DRAFT

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

POND

(No.)

CODE 378

DEFINITION

A water impoundment made by constructing an embankment or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as embankment ponds, and those constructed by the second method are referred to as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at the auxiliary spillway elevation is 3 feet or more.

PURPOSE

To provide water for livestock, fish and wildlife, recreation, fire control, and other related uses, and to maintain or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This standard establishes the minimum acceptable quality for the design and construction of low-hazard ponds where:

1. Failure of the dam will not result in loss of life; damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.
2. The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the auxiliary spillway. The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no auxiliary spillway, the top of the dam is the upper limit.
3. The effective height of the dam is 35 feet or less.

GENERAL CRITERIA APPLICABLE TO ALL PONDS

All federal, State and local requirements shall be addressed in the design.

A protective cover of vegetation shall be established on all exposed areas of embankments, spillways and borrow areas as climatic conditions allow, according to the guidelines in conservation practice standard 342, Critical Area Planting.

Site conditions. Site conditions shall be such that runoff from the design storm can be safely passed through (1) a natural or constructed auxiliary spillway, (2) a combination of a principal spillway and an auxiliary spillway, or (3) a principal spillway.

Drainage area. The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and groundwater will provide an adequate supply of water for the intended purpose unless an alternate water source exists to serve this purpose. The quality shall be suitable for the water's intended use.

Reservoir area. The topography and geology of the site shall permit storage of water at a depth and volume that will ensure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable.

For a permanent water supply, it is necessary to provide sufficient water depth to meet the intended use and to offset seepage and evaporation losses. Minimum depth of embankment and excavated ponds shall be based on drawing number 4-L-29476 or Table 11-3 in the National Engineering Handbook.

The minimum acceptable depth may need to vary where physical conditions {such as bed rock or open gravel strata) preclude the completion of the pond to the desirable minimum depth, then the acceptable minimum depth will be determined by the zone engineer.

DESIGN CRITERIA FOR EMBANKMENT PONDS

Geological Investigations. Pits, trenches, borings, review of existing data or other suitable means of investigation shall be conducted to characterize materials within the embankment foundation, auxiliary spillway and borrow areas. Soil materials shall be classified using the Unified Soil Classification System.

Foundation cutoff. A cutoff of relatively impervious material shall be provided under the dam if necessary to reduce seepage through the foundation. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and be deep enough to extend into a relatively impervious layer or provide for a stable dam when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall not be steeper than one horizontal to two vertical.

A foundation cutoff shall be installed in all embankment ponds. The cutoff should be a minimum of two feet deep below natural ground as determined by the engineer. The cutoff shall extend up the abutment to an elevation of the principal spillway or the auxiliary spillway in ponds without a principal spillway.

Seepage control. Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage could create swamping downstream, (3) such control is needed to insure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment filters and drains; (2) reservoir blanketing; or (3) a combination of these measures.

Embankment. The minimum top width for a dam is shown in table 1. If the embankment top is to be used as a public road, the minimum width shall be 16 feet for one-way traffic and 26 feet for two-way traffic. Guardrails or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority. For dams less than 20 feet in height, maintenance considerations or construction equipment limitations may require increased top widths from the minimum shown in Table 1.

Table 1. Minimum top width for dams

Total height of embankment*	Top width
Feet	*Feet*
Less than 10	6
10 – 14.9	8
15 – 19.9	10
20 – 24.9	12
25 – 34.9	14
35 or more	15

* Total height of embankment is difference in elevation in feet of the top of the dam and the lowest point in the original profile along the centerline of the dam.

Side Slopes. The combined upstream and downstream side slopes of the settled embankments shall not be less than five horizontal to one vertical, and neither slope shall be steeper than two horizontal to one vertical. All slopes must be designed to be stable, even if flatter side slopes are required. The upstream slope of the settled embankment shall not be steeper than 3 to 1. Where the maximum height of the embankment exceeds

20 feet, the back slope shall not be steeper than 2.5 to 1. Downstream or upstream berms can be used to help achieve stable embankment sections.

Slope Protection. If needed to protect the slopes of the dam from erosion, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, shall be provided (Technical Releases 56, "A guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments" and 69, "Riprap for Slope Protection Against Wave Action" contain design guidance).

Freeboard. The minimum elevation of the top of the settled embankment shall be 1 foot above the water surface in the reservoir with the auxiliary spillway flowing at design depth. The minimum difference in elevation between the crest of the auxiliary spillway and the settled top of the dam shall be 2 feet for all dams having more than a 20-acre drainage area or more than 20 feet in effective height.

Settlement. The design height of the dam shall be increased by the amount needed to insure that after settlement the height of the dam equals or exceeds the design height. Allowance for shrinkage and settling shall be made at the rate of 5 percent, except that this shall be increased to 10 percent for dams constructed with bulldozers and 20 percent with draglines. Where a combination of equipment is used, the type of equipment having higher percentage factor shall govern. Settlement shall not be less than 5 percent of the height of the dam, except where detailed soil testing and laboratory analyses or experience in the area show that a lesser amount is adequate. Dragline construction is limited to 10 feet of total embankment height.

Principal spillway. A pipe conduit, with needed appurtenances, shall be placed under or through the dam, except where rock, concrete, or other types of lined spillways are used, or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

For dams with a drainage area of 20 acres or less, the principal spillway crest elevation shall not be less than 0.5 feet below the auxiliary spillway crest elevation. For dams with a drainage area over 20 acres, this difference shall not be less than 1.0 feet.

When design discharge of the principal spillway is considered in calculating peak outflow through the auxiliary spillway, the crest elevation of the inlet shall be such that the design discharge will be generated in the conduit before there is discharge through the auxiliary spillway.

If a principal spillway is installed to reduce peak discharges in the emergency spillway, it shall be designed to prevent orifice flow. Vertical inlets shall be designed structurally to withstand external pressure from soils and hydrostatic loading.

A concrete base shall be used to prevent floatation of vertical inlets. Table 4, Gages for Vertical Inlets and Table 5, Concrete Footing Dimensions may be used in lieu of detailed designs for inlet strength and floatation requirements.

Pipe conduits designed for pressure flow must have adequate anti-vortex devices. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

Design of hooded inlets shall be in accordance with Technical Release No.3 Hood Inlets for Culvert Spillways, except the minimum head required to produce pressure flow shall be 1.8D measured from the invert of hood inlet. The anti vortex shall meet the requirements of NRCS standard drawings. A cavitation check is not required if the total available head is less than 25 ft.

The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the auxiliary spillways. The diameter of the principal spillway pipe shall not be less than 6 inches. Pipe conduits used solely as a supply pipe through the dam for watering troughs and other appurtenances shall not be less than 1-1/4 inches in diameter.

If the pipe conduit diameter is 10 inches or greater, its design discharge may be considered when calculating the peak outflow rate through the auxiliary spillway.

Pipe conduits shall be ductile iron, welded steel, corrugated steel, corrugated aluminum, reinforced concrete (pre-cast or site-cast), or plastic. Pipe conduits through dams of less than 20 feet total height may also be cast iron or unreinforced concrete.

Used welded steel pipe may be used for principal spillway fabrication provided it is approved by an authorized NRCS representative as being essentially equal in quality to new pipe and wall thickness is equal to or greater than the wall thickness in table 2.

Table 2.

Nominal Pipe Diameter* (inches}	Minimum Wall Thickness* (inches}	Weight Class*	Nominal Weight lb. per ft, Plain End,
4	0.237	STD	10.79
5	0.258	STD	14.62
6	0.280	STD	18.97
8	0.322	STD	28.55
10	0.365	STD	40.48
12	0.375	STD	49.56
14	0.375	STD	54.57
16	0.375	STD	62.58
18	0.375	STD	70.59
20	0.375	STD	78.60
24	0.375	STD	94.62
26	0.375	STD	102.63

- Reference: Table X2, ASTM A-53

National Engineering Manual (NEM) Part 543-MATERIALS 543.01 provides guidance on use of corrugated aluminum pipe.

Pipe conduits shall be designed and installed to withstand all external and internal loads without yielding, buckling, or cracking. Rigid pipe shall be designed for a positive projecting condition. Flexible pipe shall be designed for a maximum deflection of 5 percent. The modulus of elasticity for PVC pipe shall be assumed as one-third of the amount designated by the compound cell classification to account for long-term reduction in modulus of elasticity. Different reductions in modulus may be appropriate for other plastic pipe materials.

The minimum thickness of flexible pipe shall be SDR 26, Schedule 40, Class 100, or 16 gage as appropriate for the particular pipe material. Connections of flexible pipe to rigid pipe or other structures shall be designed to accommodate differential movements and stress concentrations.

All pipe conduits shall be designed and installed to be water tight by means of couplings, gaskets, caulking, waterstops, or welding. Joints shall be designed to remain watertight under all internal and external loading including pipe elongation due to foundation settlement.

Pipe conduits shall have a concrete cradle or bedding if needed to provide improved support for the pipe to reduce or limit structural loading on pipe to allowable levels.

Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe outlet.

A stability analysis of the principal spillway exit channel shall be made. If the outlet channel is unstable, grade control structures, pipe supports, or other acceptable measures shall be designed and installed to assure proper function of the principal spillway. Pipe supports shall extend below anticipated channel degradation and plunge basin scour hole. The outlet end of the pipe conduit shall extend sufficiently to assure that formation of the scour hole will not affect the downstream slope stability of the embankment.

If a pipe support is not installed, as a minimum, the outlet end of the pipe shall extend the lesser of 2.5 times the conduit diameter or 8 ft beyond the downstream toe at the channel bed.

The end section of pipe shall extend into the embankment a minimum of one conduit diameter if a pipe support is installed and a minimum of three conduit diameters without a pipe support. The extension length shall be measured from the intersection of the pipe crown and embankment slope to the upstream end of the pipe section. The minimum depth of cover over a band coupler shall be 2 feet.

All steel pipe and couplings shall have protective coatings in areas that have traditionally experienced pipe corrosion, or in embankments with saturated soil resistivity less than 4000 ohms-cm or soil pH less than 5. Protective coatings shall be asphalt, polymer over galvanizing, aluminized coating or coal tar enamel as appropriate for the pipe type. Plastic pipe that will be exposed to direct sunlight shall be ultraviolet-resistant and protected with a coating or shielding, or provisions provided for replacement as necessary

Multiple Conduits. When two or more pipe structures are laid under the same embankment, the minimum spacing between barrels shall be 3 feet. The minimum distance between the vertical inlets should be computed by the formula:

$D = 2H + 2$ where D is the minimum distance between vertical inlet in feet, and H is the head over crest or lip in feet where pipe flow occurs.

Trickle Tubes. For non-commercial fish ponds, embankment ponds with trickle tubes and principal spillway should be constructed to remove water as follows:

1. Ponds 6 feet deep or less -water shall be removed from the pond bottom.

2. Ponds more than 6 feet deep - water shall be removed from a point at least 6 feet below the water surface.

Cathodic Protection. Cathodic protection is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint-bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need.

Cathodic Protection shall be designed and installed in accordance with Design Note 12, Control of Underground Corrosion. Corrugated steel pipe with protective coatings such as asphalt, polymer, or asbestos bonded may be used without cathodic protection, if similar installations have performed satisfactorily for normal life expectancy. Noncoated galvanized or aluminized corrugated steel pipe may be installed in nonpermanently saturated soils if similar installations have performed satisfactorily for normal life expectancy.

Polymer coating or other acceptable coatings shall be installed where needed to prevent corrosion to the inside of the steel conduit.

Seepage Control. Seepage control along a pipe conduit spillway shall be provided if any of the following conditions exist:

1. The effective height of dam is greater than 15 feet.
2. The conduit is of smooth pipe larger than 8 inches in diameter.
3. The conduit is of corrugated pipe larger than 12 inches in diameter.

Seepage along pipes extending through the embankment shall be controlled by use of a drainage diaphragm, unless it is determined that anti-seep collars will adequately serve the purpose.

Drainage Diaphragm. The drainage diaphragm shall function both as a filter for adjacent base soils and a drain for seepage that it intercepts. The drainage diaphragm shall consist of sand meeting the requirements of ASTM C-33, for fine aggregate. If unusual soil conditions exist such that this material may not meet the required filter or capacity requirements, a special design analysis shall be made.

The drainage diaphragm shall be a minimum of 2 feet thick and extend vertically upward and horizontally at least three times the outside pipe diameter, and vertically downward at least 18 inches beneath the conduit invert. The drainage diaphragm shall be located immediately downstream of the cutoff trench, but downstream of the centerline of the dam if the cutoff is upstream of the centerline.

The drainage diaphragm shall be outletted at the embankment downstream toe using a drain backfill envelope continuously along the pipe to where it exits the embankment. Drain fill shall be protected from surface erosion.

The drainage diaphram shall be designed and installed in accordance with Texas NRCS standard drawings and NRCS,National Design Construction and Soil Mechanics Center - TECHNICAL NOTE - FILTER DIAPHRAGMS FOR CO-01 STRUCTURES

Anti-seep Collars. When anti-seep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe but not more than 25 feet. The minimum spacing shall be 10 feet. Collar material shall be compatible with pipe materials. The anti-seep collar(s) shall increase by at least 15 percent the seepage path along the pipe.

Minimum antiseep collar projection shall be 2 feet. One antiseep collar shall be used where the embankment fill over the barrel is 20 feet or less. Two antiseep collars shall be used where the fill over the barrel is between 20 and 25 feet. When the height of fill over the barrel exceeds 25 feet, sufficient number of antiseep collars shall be installed to increase the length of seep line of the barrel by 15 percent.

The length of conduit in the saturation zone is normally assumed to equal that portion of conduit within the confines of the embankment. When one anti seep collar is required, it shall be placed at the approximate centerline of the embankment.

Trash Guard. To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser unless the watershed does not contain trash or debris that could clog the conduit.

A debris or safety guard shall be installed on vertical inlets. The guard shall be installed according to NRCS standard drawings.

Other Outlets. A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management or if required by State law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

Drain Pipe. For non-commercial fish ponds-enclosed ponds should be designed with a drain pipe. All other ponds except "excavated" ponds should have a drain pipe. Drain pipe should have sufficient capacity to drain pond in 7-14 days.

Auxiliary spillways. Auxiliary spillways convey large flood flows safely past earth embankments and have historically been referred to as “Emergency Spillways”.

An auxiliary spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The following are minimum criteria for acceptable use of a closed conduit principal spillway without an auxiliary spillway: a conduit with a cross-sectional area of 3 ft^2 or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

The minimum capacity of a natural or constructed auxiliary spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 3, less any reduction creditable to conduit discharge and detention storage.

The auxiliary spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days’ drawdown, whichever is higher. The 10-day drawdown shall be computed from the crest of the auxiliary spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower. Auxiliary spillways shall provide for passing the design flow at a safe velocity to a point downstream where the dam will not be endangered.

The design capacity of earth spillways shall be based on the procedures and methods given in Engineering Field Handbook for Conservation Practices, Texas Engineering Technical Note No. 210-15-TX1, Erosion Control Practices, or Technical Release No.2 - Earth Spillways, and SCS-TP-61, Handbook of Channel Design for Soil and Water Conservation or based on water surface profiles.

Peak discharge shall be obtained using procedures contained in Texas Engineering Technical Note No. 210-18-TX5, Estimating Runoff For Conservation Practices or TR-55 Urban Hydrology for Small Watersheds. Peak discharge may be reduced by flood routing.

If flood routed, TR-48 Structure Analysis (SITES) or other method approved by the State Conservation Engineer shall be used on Job Class V or larger and inventory size dams. Either Average Condition Runoff Curve Number (CN) shown on Figure 1 of TETN No. 210-18-TX5 or Antecedent Moisture Condition (AMC) II may be used to determine the runoff curve number. Stream hydraulics (calculation of velocities assuming uniform or gradually varied flow conditions) is the preferred method for calculating T_c. If T_c is calculated from a published formula, the associated average velocity shall be checked for reasonableness

Constructed auxiliary spillways are open channels that usually consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth or in-situ rock. The side slopes shall be stable for the material in which the spillway is to be constructed. For dams having an effective height exceeding 20 feet, the auxiliary spillway shall have a bottom width of not less than 10 feet.

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed auxiliary spillway shall fall within the range established by discharge requirements and permissible velocities.

Structural auxiliary spillways. If chutes or drops are used for principal spillways or auxiliary spillways, they shall be designed according to the principles set forth in the Part 650, Engineering Field Handbook and the National Engineering Handbook, Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in table 3, less any reduction creditable to conduit discharge and detention storage.

Table 3. Minimum auxiliary spillway capacity

Drainage area (Ac.)	Effective height of dam[1] (Ft.)	Storage (Ac-Ft)	Minimum design storm[2]	
			Frequency (Years)	Minimum duration (Hours)
20 or less	20 or less	< than 50	10	24
20 or less	> than 20	< than 50	25	24
> than 20	20 or less	< than 50	25	24
All others			50	24

1. As defined under "Conditions where Practice Applies".
2. Select rain distribution based on climatological region.

CRITERIA FOR EXCAVATED PONDS

Drainage Area. Large drainage areas may be used as the source of water for Excavated Ponds provided the ponds can be located on sites where the flow is diverted away from the structure after the pit fills with water.

Seep type ponds may be used in areas where a subsurface water table will provide adequate supply for intended purpose.

Reservoirs completely enclosed with an embankment may be used if adequate water supply can be pumped or otherwise diverted into the pond.

Seep type ponds will be designed with the same criteria as the other excavated ponds with the following additional criteria: Location shall be made where the static water level is within 4.0 feet of the average ground elevation. The maximum depth of the pond should not exceed 10.0 feet below the static water level. The minimum depth should be at least 6.0 feet below the static water level. Sufficient number of borings shall be made and elevations recorded to determine the depth to the water-bearing strata, and to determine that the water-bearing strata are deep enough to provide adequate water.

Runoff. Provisions shall be made for a pipe and auxiliary spillway, if needed, that will meet the capacity requirements of Table 3. Runoff flow patterns shall be considered when locating the excavated pond and placing the spoil.

Side slopes. Side slopes of excavated ponds shall be stable and shall not be steeper than one horizontal to one vertical. If livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than three horizontal to one vertical.

Inlet protection. If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

Excavated material. The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and it will not be washed back into the pond by rainfall. It shall be disposed of in one of the following ways:

1. Uniformly spread to a height that does not exceed 3 feet, with the top graded to a continuous slope away from the pond.
2. Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 feet from the edge of the pond.
3. Shaped to a designed form that blends visually with the landscape.
4. Used for low embankment construction and leveling of surrounding landscape.
5. Hauled away.
6. The excavated material may be placed as follows: When the excavated material and the cut bank form a continuous slope, the front slope of the excavated material and the cut bank shall not be steeper than 2.5 to 1 and the back slope on normal angle of repose for the material. The maximum height of the excavated material not to be more than 8 feet above normal ground and the top made uniform and not left in a "moundy" condition.
7. When water is stacked against the spoil material, the finished spoil material shape shall meet the minimum requirements for freeboard, crown top width and side slopes for an embankment. Exceptions may be made by the engineer.

<u>Auxiliary Spillways</u>. Auxiliary spillways or bypass areas shall be as wide as possible to minimize flow depths. Auxiliary spillways or bypass areas shall provide for passing the design flow at a safe velocity to a point downstream where the pond will not be endangered.

A screen shall not be constructed across the emergency spillway.

Foundation Cutoff. A foundation cutoff shall be installed in all excavated ponds. The cutoff should be a minimum of two feet deep below natural ground as determined by the engineer. The cutoff shall extend up the abutment to an elevation of the principal spillway or the auxiliary spillway in ponds without a principal spillway.

CONSIDERATIONS

Visual resource design. The visual design of ponds should be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

Cultural Resources. Consider existence of cultural resources in the project area and any project impacts on such resources. Consider conservation and stabilization of archeological, historic, structural, and traditional cultural properties when appropriate.

Fish and Wildlife. Project location and construction should minimize the impacts to existing fish and wildlife habitat.

When feasible, structure should be retained, such as trees in the upper reaches of the pond and stumps in the pool area. Upper reaches of the pond can be shaped to provide shallow areas and wetland habitat.

If fish are to be stocked, consider criteria and guidance in conservation practice standard 399, Fishpond Management.

DESIGN CRITERIA FOR NON-COMMERCIAL FISH PONDS

Non-commercial fish Ponds shall meet design criteria for embankment or excavated ponds as well as the following additional criteria.

<u>Surface Area</u>. Fish ponds should have a minimum surface area of 1 acre.

<u>Minimum Depth</u>. If the water surface is held at a constant level by wells, springs, etc., the minimum pond depth should be 4 feet over at least 80 percent of the pond area.

<u>Shoreline</u>. To reduce shallow water, a minimum of 3/4 of the shoreline at normal water level should be constructed with side slopes of 3:1 or steeper to a minimum depth of 3 feet. Normal waterline is usually considered 2 feet below emergency spillway level on ponds without a trickle tube or principal spillway. The natural or undisturbed shoreline should be restricted to the upstream end of the pond surface.

Vegetation. Stockpiling topsoil for placement on disturbed areas can facilitate revegetation.

Consider placement and selection of vegetation to improve fish and wildlife habitat and species diversity.

<u>Woody Vegetation</u>. All brush, trees, stumps, and other major debris should be removed below the emergency spillway elevation in ponds which are to be intensively managed and fertilized. For those ponds not intensively managed and properly fertilized, 10 to 50 percent of the pond area below the emergency spillway elevation should be retained in standing woody vegetation. The amount of standing woody vegetation left will depend on the desires of the pond owner and the construction requirements of the pond. Brush piles (shelters) can be constructed in the deepest portion of the pond. These brush piles (shelters) should be firmly anchored to prevent floating debris.

Water Quantity. Consider effects upon components of the water budget, especially:

- Effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
- Variability of effects caused by seasonal or climatic changes.
- Effects on downstream flows and impacts to environment such as wetlands, aquifers, and; social and economic impacts to downstream uses or users.
- Potential for multiple purposes.

Water Quality

1. Consider effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that are carried by runoff.
2. Effects on the visual quality of onsite and downstream water resources.
3. Short-term and construction-related effects of this practice on the quality of downstream water courses.
4. Effects of water level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.
5. Effects on wetlands and water-related wildlife habitats.
6. Effects of water levels on soil nutrient processes such as plant nitrogen use or denitrification.
7. Effects of soil water level control on the salinity of soils, soil water, or downstream water.
8. Potential for earth moving to uncover or redistribute toxic materials such as saline soils.

PLANS AND SPECIFICATIONS

Plans and specifications for installing ponds shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Construction specifications describing the requirements for applying this practice shall be developed from the generalized construction specifications for Conservation Practice. The Construction Details section shall be used to describe site specific job requirements.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed and reviewed with the landowner or individual responsible for operation and maintenance.

GAGES FOR VERTICAL INLETS

TABLE 4
MAXIMUM HEIGHT OF INLET (FT)

STEEL PIPE

	2-2/3 x 1/2" Corrugations					3 x 1 Corrugations
Dia.	16 ga.	14 ga.	12 ga.	10 ga.	8 ga.	16 ga.
24"	25*	25*	25*	25*	25*	25*
30"						
36"						
42"						
48"						
54"						
60"	↓					
66"	21'	↓				
72"	16'	20'	↓			
78"	13'	16'	23'	↓		
84"	10'	13'	18'	24'	↓	↓

*Maximum height limit is 25 ft. for steel.

ALUMINUM PIPE

Gage	14	12	10	8		
	2-2/3 x 1/2" Corrugations				3 x 1 Corrugations	
Dia.	.075"	.105"	.135"	.164"	.075	.105
24"	20*	20*	20*	20*	20*	20*
30"						
36"	↓					
42"	17'	↓				
48"	12'	17'	↓			
54"	8'	12'	15'	↓		
60"	6'	8'	11'	14'	↓	
66"	5'	6'	8'	11'	20'	
72"	4'	5'	6'	8'	16'	↓

*Maximum height limit is 20 ft. for aluminum.

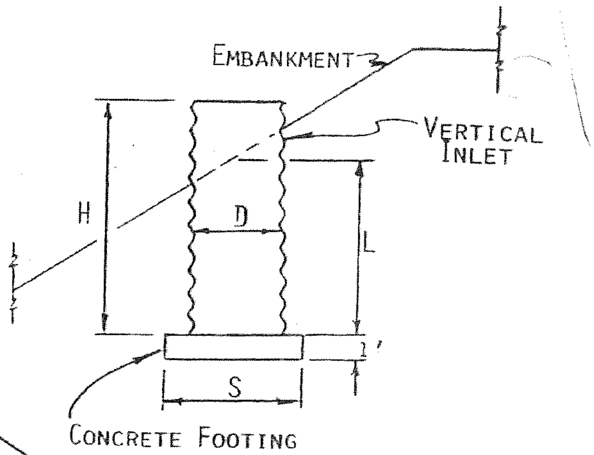
EXAMPLE: Find required gage or thickness for 66" vertical inlet 15 ft. high:

	STEEL		ALUMINUM	
Dia.	2-2/3 x 1/2	3 x 1	2-2/3 x 1/2	3 x 1
66"	16 ga.	16 ga.	None**	.075"

**Maximum length for 66" diameter .164" thick vertical inlet is 11'

CONCRETE FOOTING DIMENSION

TABLE 5



L

H	0	2	4	6	8	10	12	14	16	18	20	22	24
2.00	1.0577												
3.00	1.2954												
4.00	1.4958	1.2427											
5.00	1.6724	1.3553											
6.00	1.8320	1.4591	1.3019										
7.00	1.9788	1.5561	1.3758										
8.00	2.1154	1.6474	1.4459	1.3312									
9.00	2.2437	1.7338	1.5128	1.3862									
10.00	2.3651	1.8162	1.5769	1.4391	1.3486								
11.00	2.4805	1.8950	1.6304	1.4902	1.3925								
12.00	2.5908	1.9706	1.6977	1.5396	1.4350	1.3602							
13.00	2.6966	2.0434	1.7551	1.5874	1.4763	1.3967							
14.00	2.7984	2.1138	1.8106	1.6338	1.5165	1.4322	1.3685						
15.00	2.8966	2.1818	1.8644	1.6790	1.5556	1.4669	1.3997						
16.00	2.9916	2.2478	1.9167	1.7229	1.5938	1.5007	1.4302	1.3747					
17.00	3.0837	2.3119	1.9677	1.7658	1.6310	1.5338	1.4601	1.4019					
18.00	3.1731	2.3743	2.0174	1.8077	1.6675	1.5663	1.4893	1.4287	1.3795				
19.00	3.2600	2.4351	2.0658	1.8486	1.7031	1.5980	1.5180	1.4549	1.4037				
20.00	3.3447	2.4944	2.1132	1.8886	1.7381	1.6292	1.5462	1.4807	1.4275	1.3834			
21.00	3.4273	2.5524	2.1595	1.9278	1.7723	1.6597	1.5739	1.5060	1.4509	1.4051			
22.00	3.5080	2.6090	2.2048	1.9662	1.8059	1.6897	1.6011	1.5309	1.4739	1.4265	1.3865		
23.00	3.5868	2.6644	2.2493	2.0039	1.8389	1.7192	1.6278	1.5555	1.4966	1.4477	1.4063		
24.00	3.6640	2.7187	2.2928	2.0409	1.8713	1.7482	1.6541	1.5796	1.5189	1.4685	1.4258	1.3891	
25.00	3.7395	2.7720	2.3356	2.0772	1.9032	1.7767	1.6800	1.6034	1.5409	1.4890	1.4450	1.4072	
26.00	3.8136	2.8242	2.3776	2.1129	1.9345	1.8047	1.7055	1.6268	1.5626	1.5092	1.4640	1.4251	1.3913

S/D FACTORS

EXAMPLE:

L = 10 FT
H = 15 FT
D = 4.0 FT

FROM TABLE S/D = 1.4669
S = (1.4669)(4.0) = 5.87 FT ≈ 6.0 FT
USE 6' x 6' x 1' CONCRETE BASE

APPROVAL AND CERTIFICATION

POND

(No.)

CODE 378

PRACTICE STANDARD APPROVED:

State Conservation Engineer	**Date**